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Cryogenic Test Stand Facilities at PAB:

Stephen Pordes

Neutrino R&D Workshop

January 20 – 21 2016

Philosophy statement in 2012

How to develop the expertise to enable a program for a multi-kiloton LArTPC :

Learn as much as we can from previous work (especially ICARUS)

Develop hands-on experience and our own (new) infrastructure

- filters, cryogenics, pumps, HV feed-throughs, readout electronics

Look at technical topics which may not have been fully explored previously

- material tests, in-liquid electronics, light detection

Put a LArTPC in a neutrino beam to exercise a complete system

- ArgoNeuT

Demonstrate good electron lifetime *in an **unevacuated commercial vessel***

- LAPD (Liquid Argon Purity Demonstration)

Expose LArTPC to a beam of known energy and different particle types

- LArDBT (Liquid Argon Detector Beam Test) (now LArIAT)

Philosophy for Cryogenic Test Stands at the PAB

- Relevant and not duplicative
 - abandoned TPC front-end readout when BNL started working on the topic
- Encourage close relations with University groups to use existing facilities, and support developments for new work
 - Indiana, M.I.T., Michigan State, Michigan, Yale ...
- Provide facilities where we can exploit expertise at Fermilab and give other groups opportunities to demonstrate and develop their ideas
 - Xenon and other dopants, PMT readout via the TPC wires, light sensors,
- Facilities designed for R & D - if appropriate may be used to develop equipment for a specific experiment (e.g., for prototyping)
 - ArgoNeuT electronics prototyping, DUNE light-detection system tests

Cryogenic Test Stands at the PAB

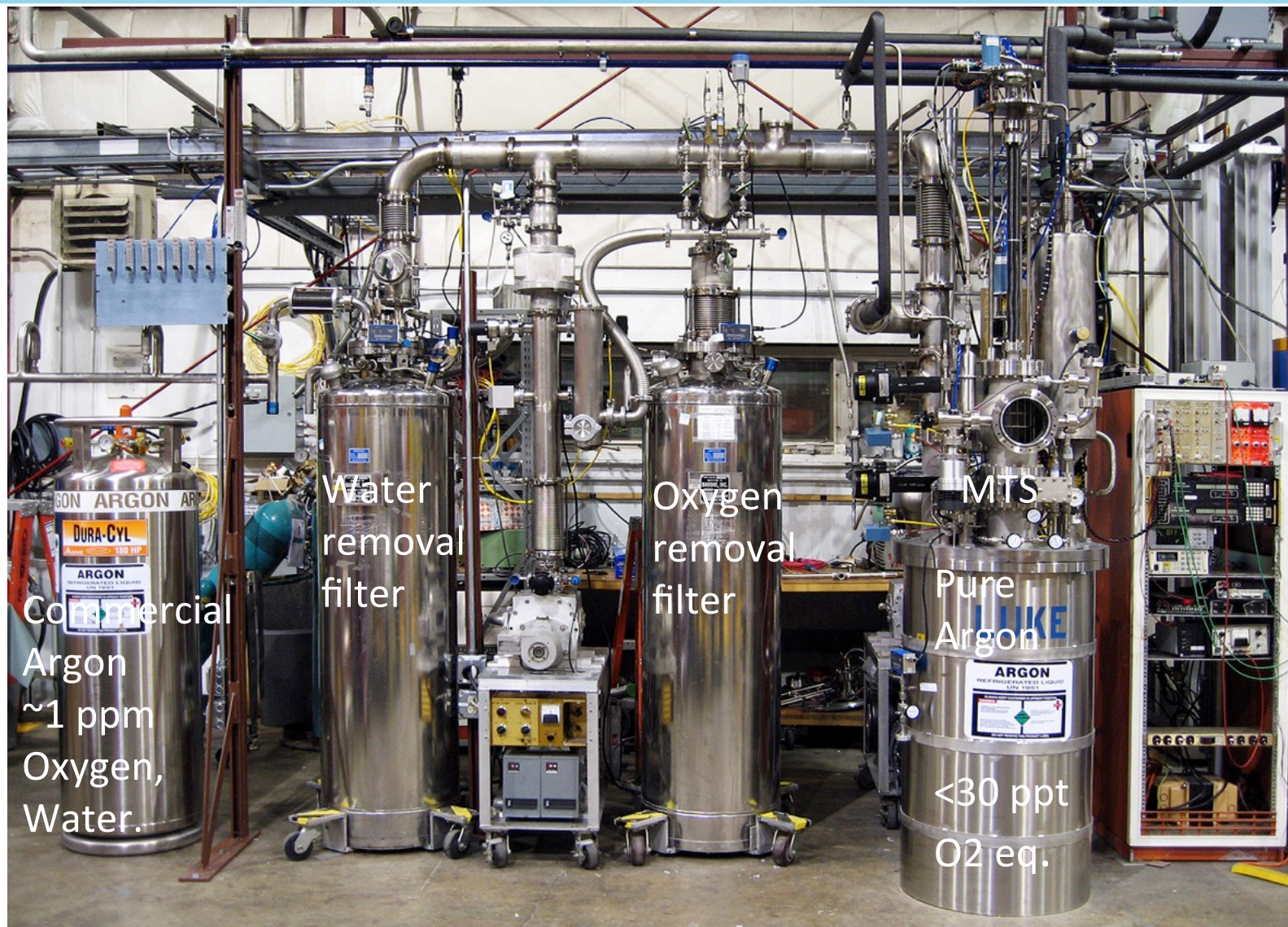
- **Materials Test System (MTS)** - Certification of detector materials
- **TalBO cryostat** - Light Detection and Production
 - Effect of contaminants and additives (quenching, attenuation)
 - Detector Performance (light collection, photosensors)
- **BLANCHE cryostat** - High Voltage
 - Breakdown in noble liquids (geometry, materials, purity effects)
- **ScENE cryostat** – Small (transportable) TPC system
- (LArIAT (LArTPC in a Test Beam), and the LAPD and 35 ton systems in the PC-4 hall are described in other presentations. Apparatus to `grow' Solid Xenon is not discussed.)

Common Infrastructure for MTS, TalIBo, BLANCHE

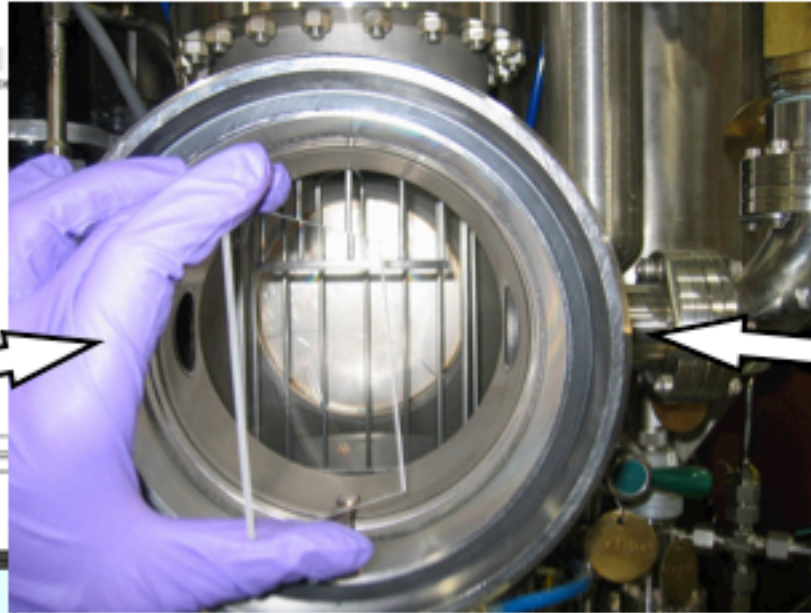
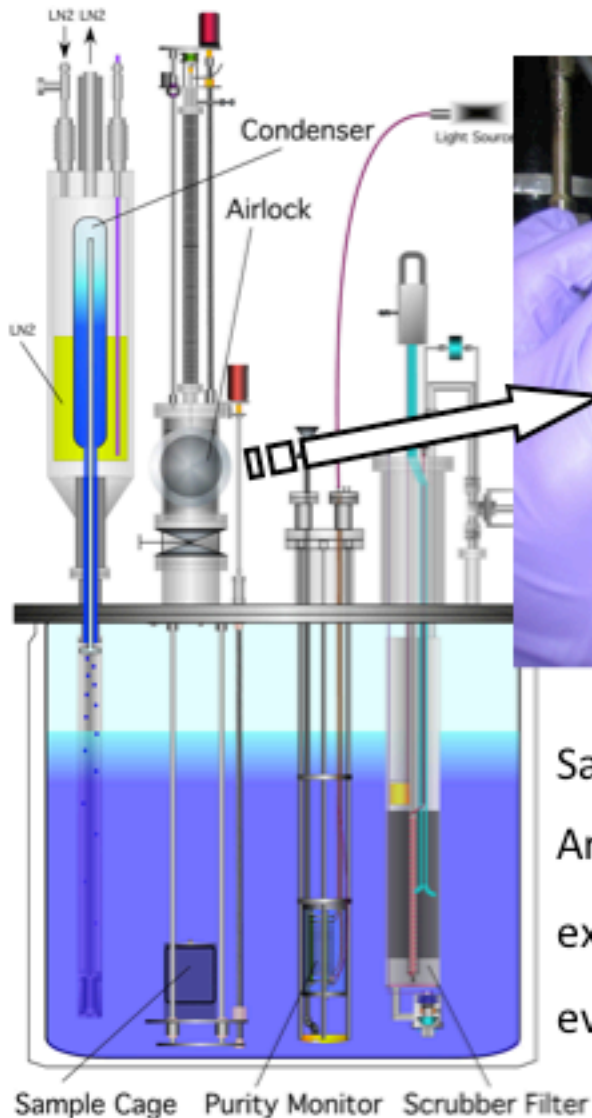
- PAB staff of technicians and engineers
- Source of clean argon – our own regenerable filter system
- Nitrogen condensers to keep liquid indefinitely
- Cryogenics Control and Data Acquisition System (iFix based)
- Analytic Equipment: Water, Nitrogen, and Oxygen Monitors
- ICARUS style purity (drift-lifetime) monitor
- - HV supply down to -150 kV
- Contaminant Injection system (used for O₂, CH₄, N₂, Xe)
- Oscilloscopes (developed into DAQ by M.I.T.)
- Standard NIM electronics through PREP
- Local office-space and living amenities
- **Do not have:**
 - generic data acquisition for detectors
 - supply of cryogenic PMTs
 - fine-grain cosmic ray hodoscope



Argon Source & Materials Test System



Materials Test System



Sample volume 10 cm x 10 cm x 10 cm
Argonlock can be purged with
external argon, cryostat argon, and/or
evacuated



Materials Test System output

'A system to test the effects of materials on the electron drift lifetime in liquid argon and observations on the effect of **water**' R. Andrews *et al.*, Nucl.Instrum.Meth.A608:251-258,2009.

Material	Date test started	Preparation	Tests	Water [ppb]	Lifetime [ms]	LogBook #
Cleaning Solution	6/29/09	evac. 24 h	vapor/liquid	4	5	946
Vespel	7/9/09	evac. overnite	liquid/vapor	5-7	2-5, 4-6	960
MasterBond glue	7/16/09	purged 18 h	vapor/liquid	1.6	1.3- 2.9	974
LEDs	7/31/09	purged 38 h	vapor	3.5	5	993
Carbon filter material	8/12/09	evac. 24 h	liquid/vapor	2	4-9	1000
962 FeedTru Board V2	10/12/09	evac. 24 h	vapor/warm	85	1-5	1062
Teflon cable	1/9/10	purged 28 h	warm/liquid/vapor	8-20	2-5	1175
3M "Hans" connectors	1/29/10	purged 46 h	warm/liquid/vapor	5-12	3	1198
962 capacitors	3/2/10	evac. 24 h	warm/liquid/vapor	6-14	3-6	1228
962 polyolefin cable	4/12/10	evac. 16 days	warm	25-60	2	1237
Rigaku feedthrough	4/20/10	purged 7.5 h	warm	15	3	1250
Rogers board (Teppe)l	4/23/10	purged 26 h	warm/liquid/vapor	40	2, 6-10	1254
Arlon Board (Teppe)l	5/14/10	evac. 0.5 h, pur.2 days	warm/vapor	300, 80	1.3, 3.5	1263
Polyethylene tubing	5/24/10	evac. 6 h, pur. 66 h	warm	300-500	1	1278
Teflon tubing	5/27/10	evac. 1 h, pur.17 h	warm	9-13	4-5	1283
Jonghee board	5/28/10	evac. 6 h, pur. 1.5 h	warm/vapor	100,28	1.2, 5-8	1285
Jonghee connectors	6/4/10	evac. 3.5 h, pur. 16 h	warm/vapor	50	2-3	1290
PVC cable	6/14/10	evac. 29 h, pur.1 h	warm	120	1-2	1296
Teppe)l TPB samples	8/3/10	purged 26 h	warm	600-1600	0.7	1342
Teppe)l TPB samples	9/4/10	purged 37 h	liquid /vapor	15, 300	6	
PrM feed tru (baked)	10/5/10	purged 25 h	warm/vapor	35, 20	3, 2	1396
Copper foil on mylar film	10/14/10	purged 26 h	warm/liquid/vapor	15, 10, 9	3, 8, 7	1409
Teppe)l SHV connector	10/25/10	purged 25 h	warm/vapor/liquid	35, 11, 0	2, 6, 6	1415
FR4	11/16/10	purged 25 h	warm/liquid/vapor	180, 20, 65	1.5, 6, 2.5	1429
Gaskets	3/11/11	purged 24 h	warm/liquid/vapor	8, 10	2.5, 8, 7	1521
LBNE AP-219 Color. Developer	4/13/11	purged 25 h	warm/vapor	65, 15	4, >6	1722
LBNE RPUF Foam	4/22/11	evac. 26 h, pur.1 h.	warm	800	0.2	1729
LAPD LEDs	5/12/11	purged 49 h	vapor	0.6 ppb	10	1769

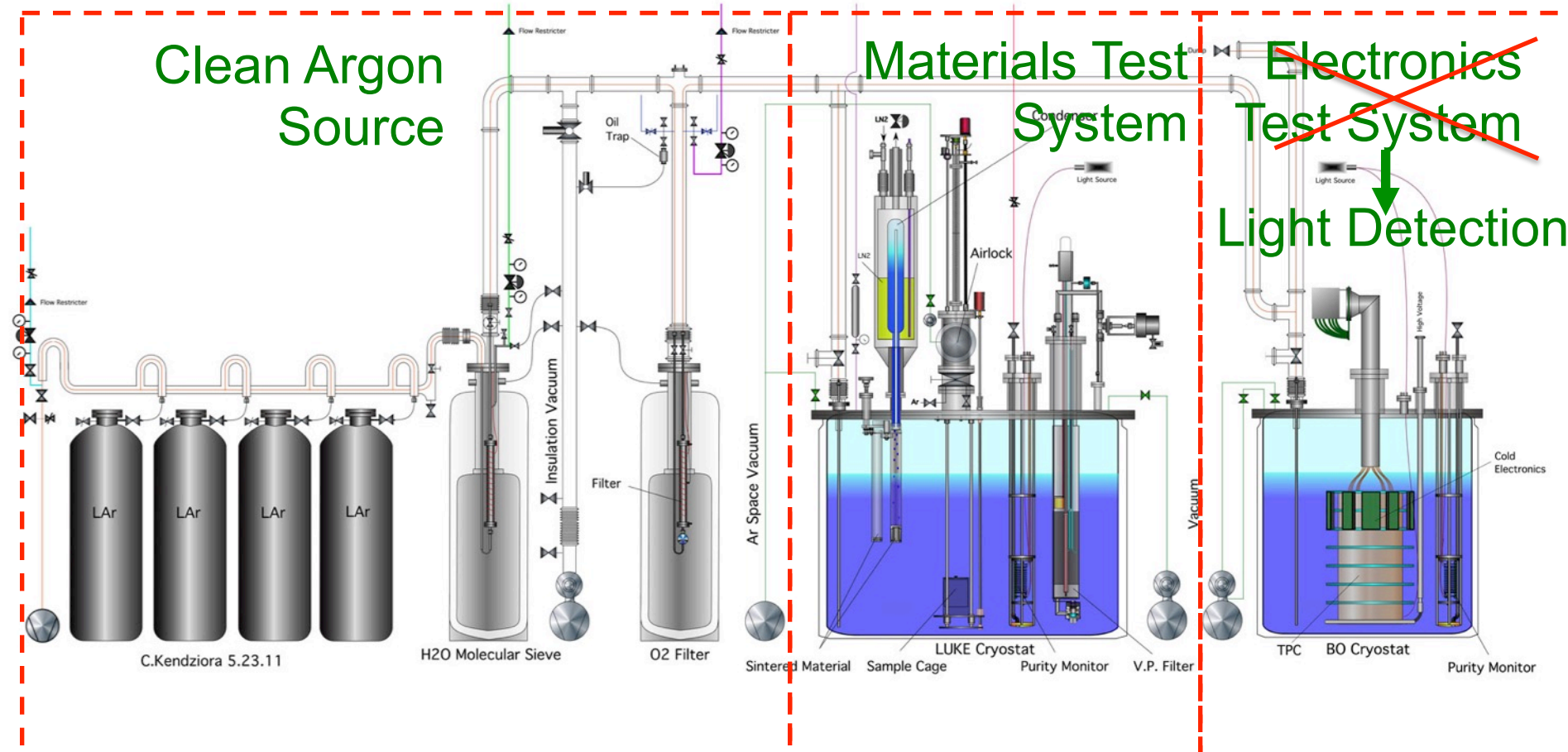
Sample data on different materials (bad, good, OK in liquid)

Liquid Argon Setup at the PAB

Clean Argon
Source

Materials Test
System

~~Electronics
Test System~~
Light Detection



Schematic of Materials and Light Detection Test Systems

Bo to TallBo for light

Light Studies (M.I.T.) – effect of Nitrogen on attenuation length

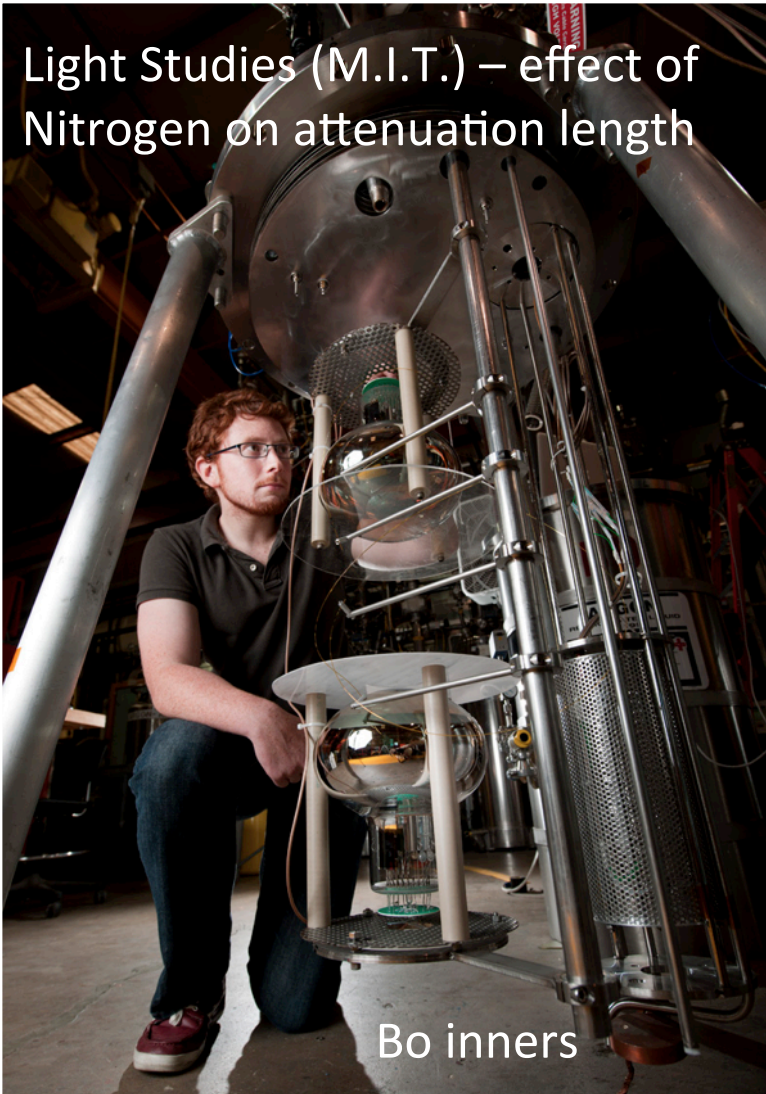


Photo-detector studies for DUNE
(Indiana U., Argonne)



BLANCHE HV Cryostat (recent addition)

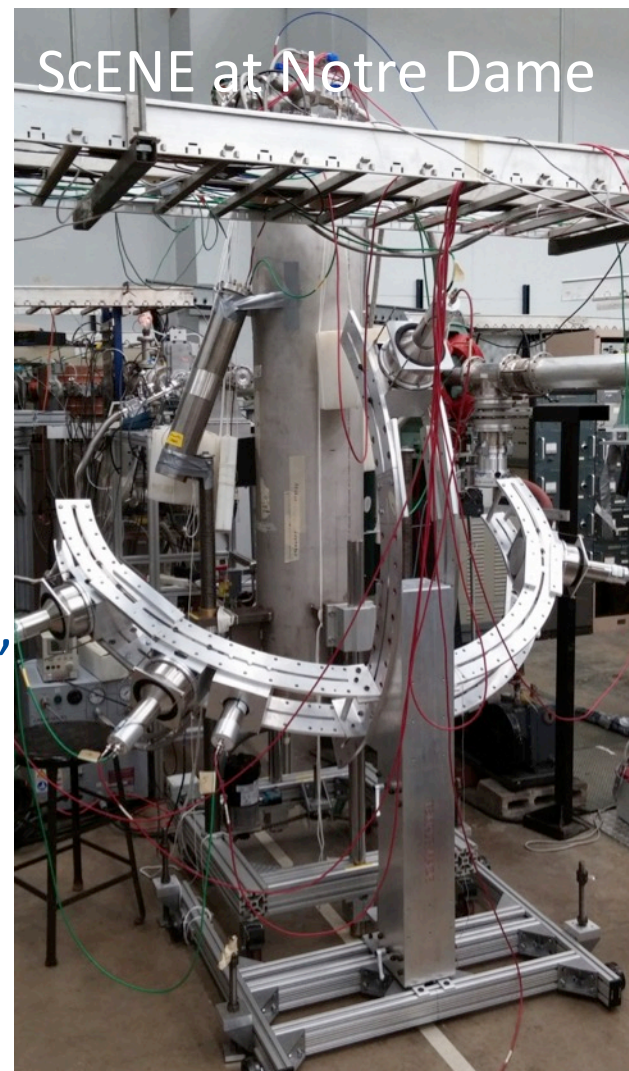
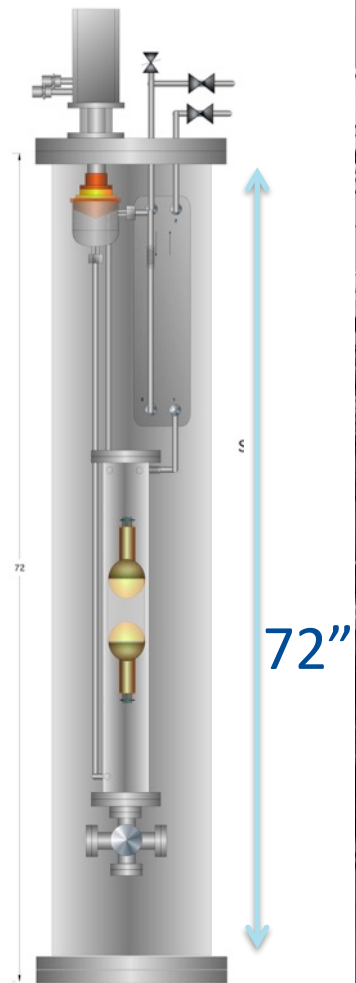


Rogowski style HV Probe

ScENE – Scintillation Efficiency of Noble Elements

Small TPC (3" by 8") in self-supporting system (cryocooler and gas getter for purification)

First used at Notre Dame to measure light-yield for nuclear recoils in argon.



The near-term Future

Requests for use and suggestions for improvements very welcome

Tall Bo, Blanche and Scene have users for the next few months but we have found people are generally flexible.

MTS is generally available (one-week turn around).

Would like to implement improvements to existing equipment in particular to install moving a mechanism in TallBo to allow, e.g., source measurements at different positions along a light-bar

<http://neutrino.fnal.gov/facilities/userinfo/schedule.html> is link to book

<http://lartpc-docdb.fnal.gov> has whole history – and real drawings.

Can always contact Brian (brebel@fnal.gov) or me (stephen@fnal.gov)

End & Extra

Liquid Argon Purity Demonstration (LAPD)

Long Bo 2 m drift
LAr TPC

1st large scale
purification
system built at
Fermilab

LArTPC used in
liquid amplifiers
giving $S/N > 30$

1st demonstration
of long drift in a
cryostat which
was not
evacuated.

